

Northeast SARE LNE07-263

Developing farmers' skills and confidence in the use of *Trichogramma ostrinae* for European corn borer control in sweet corn, peppers and potatoes

Summary: This project focused on increasing adoption of biological control of European corn borer (ECB) in sweet corn, peppers, and potatoes using *Trichogramma ostrinae* (T.ost), a tiny wasp that attacks ECB eggs. T.ost has been shown in prior research trials to improve crop quality by reducing ECB infestation, and/or insecticide applications. Using biological control is an unfamiliar practice for many farmers and proper handling, release timing, and field placement are critical to success. We used on-farm demonstrations, presentations, newsletter articles, and developed fact sheets to help farmers become more familiar with using *Trichogramma*. We conducted on-farm demonstrations with 44 farmers over three years. Our goal was to have 25 of the growers we collaborated with purchase and use *Trichogramma* on their own after the collaboration, and for 20 of those growers to report at least two benefits from using *Trichogramma* in sweet corn, pepper or potato. In 2010, 24 of the 44 farmers we worked with in 2007-2009 purchased T. ostrinae from IPM Laboratories, the only U. S. supplier, one less than our goal. Additional farmers learned about using *Trichogramma* through presentations, newsletter articles, and a fact sheet. Our goal was to have fifteen growers of these growers try *Trichogramma*. Growers who purchased T. ostrinae from IPM Labs in 2009 or 2010 were surveyed in the fall of 2010. Twenty farmers who collaborated in on-farm demonstrations reported two or more benefits of using the wasps for ECB control, meeting our goal. An additional 24 farmers purchasing T. ostrinae in 2010 learned about them through presentations or newsletter articles, exceeding our goal. Of these, 17 reported two or more benefits of using T. ostrinae, which was not an explicitly stated performance target, but an extension of our goals for farmers who collaborated in on-farm demonstrations.

Introduction: Numerous research and demonstration trials have shown that releases of the parasitic wasp *Trichogramma ostrinae* (T.ost) can be an effective management strategy for European corn borer control in sweet corn, peppers, and potatoes, however adoption has been hampered by farmers' unfamiliarity with the T.ost and the most effective strategies for their use. We had already demonstrated to ourselves and a small number of farmers that the wasps can be very effective. We wanted as many additional farmers as possible to give the wasps a try, so focused on helping growers understand the critical elements for success with the wasps and minimized the amount of efficacy data we collected, instead using grower adoption and satisfaction as measures of the success of the project.

Objectives/performance targets

1. *Of the 35 growers who collaborate with the project during the two years of demonstrations, 25 will purchase and release T. ostrinae for European corn borer control on their own during the third year.* We worked with 44 growers over the course of the project, exceeding our goal. Twenty four of these farmers purchased T.ost from IPM Laboratories in 2010, one short one of our target.

2. *Of these 25 growers, 20 will report at least two of the following changes with respect to sweet corn, pepper or potato: improved harvest quality or yield; reduced use of insecticide applications for European corn borer control; reduced labor, fuel, or other costs associated with European corn borer control; increased crop acreage; increased net income; improved customer satisfaction; reductions in European corn borer moth trap captures or infestations compared to previous seasons; increased integration of sweet corn as a rotation crop into vegetable/cover crop rotation plan.* Twenty growers who collaborated on the project reported two or more of the above benefits of using *T.ost* for ECB control, which met our target.
3. *Fifteen growers (of 150) who attend twilight or winter meetings will try *T. ostriniae* on their farm.* Twenty four farmers who did not directly collaborate with the project team but heard presentations at twilight or winter meetings or read newsletter articles purchased *T.ost* from IPM Laboratories in 2010. Although we did not include newsletter articles as a form of outreach in this performance target, in retrospect we should have, so consider this to exceed our target.

Materials and methods *Trichogramma ostriniae* (*T.ost*) wasps used in these trials were reared on *Ephestia kuehniella* grain moth eggs by either the Hoffmann lab at Cornell University, or IPM Labs, Inc. in Locke, NY. Wasps were released in the pupal stage inside grain moth eggs glued to heavy paper folded into a release packet to protect the pupae from naturally-occurring predaceous insects in the field. Packets were tied to corn stalks, pepper, and potato plants, or to wooden stakes where plants were too small to tie packets to. Packets were distributed evenly throughout the planting, staying 50 ft. from field edges where possible. Wasps were observed to emerge from release packets over a two week period after placement. The first releases in sweet corn targeted the 6-8 leaf stage, with two additional releases at weekly intervals after that. In sweet corn, release rates ranged from 30,000 to 60,000 per acre. In NY, 30,000 wasps were released per acre for all releases in 2007 only, and releases continued through the growing season in all years. In MA, and in NY after 2008, an initial release of 30,000 per acre was followed by two subsequent releases of 60,000 per acre. In MA, releases in sweet corn were conducted during the first generation ECB flight only.

Between 100,000-120,000 wasps per acre were released in pepper fields with fruit walnut-size and larger. Pepper fields received 2-4 releases, one week apart, bracketing the ECB flight, which was monitored using pheromone traps. In Virginia releases occurred during the first generation flight; in NY, MA, VT, and PA releases were made during the second generation flight. *T.ost* were released in potato at a rate of 100,000 per acre and the two releases, one week apart, in each field coincided with the first generation ECB flight. Table 1 in the Results and Discussion section summarizes the different release rates used.

Sweet corn fields were scouted using recommended IPM methods by farmers or project personnel to determine if ECB infestation levels were below threshold at tassel emergence. Scouting for ECB is nearly impossible in peppers and potatoes so was not attempted. Levels of ECB infestation were determined at harvest by examining 100-200 randomly

selected sweet corn ears or peppers for infestation or ear damage by ECB. ECB damage in potato was evaluated by examining 100 randomly selected stems for ECB tunneling.

To determine if we met our performance target of 25 growers purchasing T.ost on their own after collaborating with the project, we obtained the list of IPM Labs customers buying wasps in 2009 and 2010. IPM Labs is the only supplier of T.ost, so all growers using them on their own are on the list. To measure the other performance targets we conducted a mail survey of all growers who purchased T.ost from IPM Labs in 2009 or 2010.

Results and discussion/milestones We interviewed sweet corn, pepper, and potato growers during the winter of 2006/07 to determine their interest in participating in this project and recruited 30 farmer collaborators for the 2007 growing season. Some cooperating growers were using insecticide applications for controlling ECB, while others were not using any controls prior to releasing wasps. Wasps were released in sweet corn on 20 farms in a total of 73 plantings in 2007. In NY, wasps were mailed directly to farmers, who placed them in the field on their own after initial training from project staff on handling and placement. In the other states, project staff placed the wasps in the field. A cool spring followed by a sudden heat wave that accelerated ECB moth emergence made timely releases in early sweet corn challenging. Some fields did not receive the first release the week the ECB flight started. An early indicator of whether T.ost is providing effective control in sweet corn is the level of ECB infestation at tassel emergence. Experience has shown us that in fields not receiving releases, at least 90% of early sweet corn fields are over threshold at tassel emergence due to larvae that are a product of eggs laid during the first generation flight. These are the eggs targeted with the T.ost releases. Assessing whether fields receiving releases are over threshold at this phenological stage is a good early indicator of the effectiveness of the T.ost releases, and 29% were over threshold at tassel emergence, indicating that 71% may have eliminated at least one insecticide application. Depending on the grower, some fields that were over threshold received an insecticide application, others did not. ECB infestation levels (live larvae or damage to the ear) at harvest averaged 6.3%. This figure included fields that were sprayed if over threshold and those that were not. Very early and very late fields were more likely to have higher levels of infestation than mid-season fields. Wasps were released in 6 pepper fields in VA, MA, VT, PA, and NY. Not all were formally evaluated for damage at harvest, but those that were averaged less than 10% infestation. Some pepper fields were sprayed in addition to receiving releases. Releases were made in four potato fields in VA. ECB trap catches near the potato demonstration fields were low and resulting stem infestation levels averaged 2.4%.

During the winter of 2007/2008 we met with collaborating farmers in MA, VT, and NY to review results, get feedback on their experiences with the releases, and to see if we were on track for our performance targets. Feedback was generally very positive and farmers reported two or more benefits on using the wasps, indicated that we were on track. We received suggestions to package wasps in smaller numbers to allow better retention in long, narrow fields and to eliminate any metal in the packaging to allow feeding of chopped corn stalks to animals after harvest. Most growers indicated a need for at least one more

year of collaboration to feel comfortable using the wasps on their own. Project staff discussed release timing and rates in a conference call and made a decision to use 60,000 per acre for releases 2 and 3 in sweet corn and to use degree days to better forecast moth emergence in 2008 to help with timing the initial releases. We also decided to mail wasps directly to growers in both NY and MA and have them place them in the field to help them transition to what they will experience once purchasing them on their own.

During the 2008 growing season wasps were released in sweet corn on 24 farms in New York and Massachusetts, and in peppers on five farms in MA and southern VT. In New York, seven of the nine farmers using T.o.st in sweet corn in 2007 also participated in 2008, and three new farmers were added. In Massachusetts and Vermont, nine of 13 farmers from 2007 participated in 2008, and five new farmers were added. Release timing was very good for the initial releases in 2008. Not all plantings were scouted at tassel emergence, but of the 55 that were, 31% were over threshold, indicating that 69% of plantings could have saved at least on insecticide application. In MA, infestation levels at harvest were mainly below 5%, including fields that were sprayed and not sprayed. In NY, where harvest evaluations were conducted in 18 fields, infestation levels averaged 12% and none were sprayed. Releases were made in 8 pepper fields on 5 farms in MA, and no harvest evaluations were conducted by project staff.

In Virginia, the adoption of a new insecticide in potatoes and a decline in corn borer populations thought to be associated with widespread use of field corn genetically engineered to express Bt toxins (Kuhar et al. 2010, Hutchison et al. 2010) made T.o.st releases a less attractive option for farmers. To enlist farmers interested in trying T.o.st releases in peppers an offer was made to subsidize the cost of wasps for farmers ordering from IPM Laboratories, the commercial insectary that is rearing and supplying them. A press release was sent out to farmers and extension staff in Virginia, Delaware, and Pennsylvania. Only two farmers took advantage of that offer in 2008, so we extended the on-farm demonstrations into 2009 to increase our chances of meeting our performance targets. In VA, work on T.o.st dispersal in potatoes to determine the optimal release points per acre in peppers, and work on integrating biological and chemical control in peppers was completed in 2007 and 2008 (Chapman et al. 2009a, 2009b).

We met with collaborating growers again in the winter of 2008/2009 to get feedback and assess if we remained on track for our performance targets. Growers again generally indicated a good experience and two or more benefits of using *Trichogramma* for ECB management. We also asked growers if they felt comfortable releasing on their own in 2009 and those who did “graduated” to using wasps on their own with as much support as needed from project staff. A set of written guidelines for using wasps and a copy of the online fact sheet were distributed to “graduates” in NY.

In 2009, wasps were released in sweet corn in 35 plantings on 13 farms in NY and MA, and in peppers in 7 fields on 5 farms in MA. Three new farmers were added in MA. Because of disappointing results in NY in the earliest season extension (transplanted or direct seeded and row-covered) fields in 2007 and 2008, rates of 60-120,000 (60, 120, 120) wasps per acre were made on two farms that focus on early season corn. Wasps may be less effective

in the very early season because low temperatures and/or rainfall inhibit movement. At one farm an unreplicated comparison of a field receiving the higher rates and one receiving the usual rates (30,000-60,000/A) was conducted. Both farms experienced lower ECB infestations at tassel emergence where the rates were increased. The 2009 season was persistently cool and rainy and the effects of rain were evident in observations of release packets falling apart, T.ost pupae in packets covered with mold, and higher levels of infestation in many release fields. Scouting and harvest evaluations were not conducted in NY, but a release field scouted during an on-farm workshop was heavily infested. In MA and VT, 33% of sweet corn fields receiving releases were over threshold at tassel emergence, higher than in previous years, and damage at harvest ranged from 4-40%. In peppers, fruit damage at harvest was 0 for 6 of the 7 fields and 2% in the seventh.

Table 1. Summary of release rates used in the on-farm demonstrations

Crop	Year(s)	State	N Releases per Field	Release rate(s)/A*	Results
Sweet corn	2007	NY	3	30K, 30K, 30K	79% UT at TE**
Sweet Corn	2007	MA, VT	3	30K, 60K, 60K	68% UT at TE
Sweet corn	2008	MA, NY, VT	3	30K, 60K, 60K	69% UT at TE
Sweet Corn	2009	MA, NY, VT	3	30K, 60K, 60K	57% UT at TE
Earliest Sweet Corn	2009	NY	3	60K, 120K, 120K	100% UT at TE
Peppers	2007	VA	2	100K	< 10% ECB damage
Peppers	2007	PA	2-3	120K	0-2% ECB damage
Peppers	2007	MA, NY, VT	4	120K	0-12% ECB damage
Peppers	2008	MA, VT	4	120K	No harvest evaluations
Peppers	2009	MA, VT	4	120K	0-2% ECB damage
Potatoes	2007	VA	2	100K	0-9% damaged potato stems

* Where multiple rates appear, rates are for week 1, week 2, and week 3 respectively

** UT – under threshold, TE - tassel emergence

2010 was the evaluation year for this project and no field work was conducted. In the fall of 2010 a survey was developed (Appendix 1) and mailed to the IPM Laboratories customers who purchased T.ost in 2009 or 2010, to evaluate our performance targets. Surveys were mailed to 84 farms, and 50 were returned. Four of these were not useable because they had not been filled out completely or because wasps were not being released

in our target crops. An additional 7 growers responded to the survey via telephone interview for a total of 53 useable responses.

Impact of results/outcomes: Directly addressing outcome targets, twenty of the respondents who indicated that they had direct contact with the project team experienced two or more of the benefits targeted in our outcomes as a result of releasing T.ost. Twenty four growers reported attending presentations or reading newsletter articles by project staff, and 17 of those also reported two or more of the benefits cited in our performance target.

Sixty four percent of farmers responding to the survey use organic practices on some or all of their acreage. All reported growing sweet corn (an average of 18 acres), 66% grow peppers (average 1 acre), and 51% grow potatoes (average 2 acres). Ninety two percent are releasing T.ost in sweet corn, 32% in peppers, and 2% are releasing in potato. The low potato figure is not surprising as ECB is rarely a pest in potato in NY and New England. Seventy percent are marketing through roadside stands, 40% through farmer's markets, 36% through a CSA, and 73% sold through wholesale markets. Respondents reported using an average of 2.3 different market channels.

Forty percent reported direct collaboration with the project team as an influence on their decision to use T.ost. Forty percent reported being influenced by a presentation, and 49 percent by a newsletter article (some by two or all three). Fifteen percent cited another farmer as an influence, 32% cited IPM Labs (which provides excellent customer service and phone consulting), and 7% by the online fact sheet. Other influences (13%) were mainly Extension agents and consultants. Respondents reported an average of 2 different factors that influenced their decision.

A summary of responses to questions about benefits of using T.ost from the 45 survey respondents who reported contact with the project (direct, or through presentations or newsletter articles) is in Table 2.

Benefit of using T.ost	Percent Respondents Reporting*
Improved quality (fewer ECB worms) at harvest	71
Improved customer satisfaction	55
More marketable sweet corn ears/peppers	58
Increased potato yield	0
Increased net income for sweet corn, peppers, or potatoes	27
Fewer insecticide applications against ECB	49
Reduced late season ECB pressure	38
Reduced ECB pressure compared with years prior to releasing	44
Reduced fuel use for ECB management	29
Reduced labor costs for ECB management	33
Other	11

*N = 45

Table 2. Reported benefits of using T.ost

The benefits of T.ost releases will vary with grower practices. Growers who had been using no controls for ECB prior to trying T.ost releases would be most likely to report improved quality and customer satisfaction. Growers who are incorporating T.ost releases into an already successful IPM program would be unlikely to experience improved quality, and more likely to benefit from reduced insecticide applications and reduced fuel cost. Benefits cited in the “other” category include reductions in aphid pressure because natural enemies are not disrupted by insecticide applications, the fact that releasing wasps is easier and more pleasant than suiting up and spraying, and time freed up from spraying to perform other important tasks.

Respondents rated their overall satisfaction with using T.ost at 7.5 on a scale of 1-10, with 10 being very satisfied. They rated ease of use at 8.7 on a scale of 1-10 with 10 being very fast and easy, and cost at 7 on a 1-10 scale with 10 being very affordable.

Growers who indicated that they would spray if release fields went over threshold reported an that average of 41% of fields needed an insecticide application in addition to the T.ost releases.

Eighty eight percent of respondents indicated that they intended to continue releasing T.ost in the future.

Commonly cited obstacles to respondents’ successful use of T.ost include the impact of weather on the effectiveness of the wasps, being unsure of proper release timing, especially in areas without pheromone trap information, and especially for the first release, which often must be ordered before moths start to fly in the spring.

Publication and Outreach: In 2007, information about the project and the use of T.ost was presented at 12 grower meetings and in one newsletter article. A fact sheet on using the wasps was developed and posted as a pdf on the NYS IPM program web site (http://www.nysipm.cornell.edu/factsheets/vegetables/swcorn/trich_ost.pdf). In 2008 the project team included information about T.ost in nine presentations to grower audiences and and at one on-farm workshop. In 2009 information was included in two presentations to grower audiences and at one on-farm workshop. Audience numbers were collected for some but not all of the presentations. Numbers were well over our milestone of 150 farmers. While feedback and evaluation was conducted at some of the presentations and workshops, the farmer survey is our primary means of evaluating how effective they were in influencing farmers to try T.ost. . At least one article about using Trichogramma was published and disseminated in each year of the project to MA growers through Vegetable Notes newsletter (circulation 600-800).

Massachusetts published a guide for using IPM in sweet corn (Using IPM in the Field: Sweet Corn Insect Management Field Scouting Guide) that includes instructions on releasing *Trichogramma ostrinae*. Five hundred copies of the first edition were distributed to

growers at educational programs and through county offices in MA. An additional 200 copies have been purchased and distributed by Johnny's Selected Seeds. The guide is available online at <http://extension.umass.edu/vegetable/publications/sweet-corn-ipm-guide>

Publications:

Hazzard, R, A. Brown and P. Westgate. Using IPM in the Field: Sweet Corn Insect Management Field Scouting Guide. 52 pp. UMass Extension Publication.
<http://extension.umass.edu/vegetable/publications/sweet-corn-ipm-guide>

Chapman, A. V., T. P. Kuhar, P. B. Schultz, and C. C. Brewster. 2009a. Dispersal of *Trichogramma ostrinae* (Hymenoptera: Trichogrammatidae) in Potato Fields. *Environ. Entomol.* 38(3): 677-685

Chapman, A. V., T. P. Kuhar, P. B. Schultz, T. W. Leslie, S. J. Fleischer, G. P. Dively, and J. Whalen. 2009b. Integrating Chemical and Biological Control of European Corn Borer in Bell Pepper. *Journal of Economic Entomology* 102(1):287-295.

Seaman, A.J., M.P. Hoffmann, and M. M. Woodsen. 2008. Using *Trichogramma ostrinae* to help manage European corn borer in sweet corn, peppers, and potatoes. Online at: http://www.nysipm.cornell.edu/factsheets/vegetables/swcorn/trich_ost.pdf

Areas needing additional study: We need to figure out ways to inspire farmers to try T.ost and ways to motivate them to continue. Because of the potential impacts of cool and rainy weather, and other inconsistencies resulting from working with a living organisms, T.ost is less consistently effective than using scouting and thresholds, but the risk of infested corn can be effectively reduced by backing up releases with scouting to determine if the wasps reduced the ECB population below threshold, and application of insecticides if they did not. Lack of consistency has limited adoption by conventional growers who are very successful managing ECB with insecticides because they lack incentives to adopt. Growers who don't have the equipment to spray or have a market that awards crops grown without insecticides also endure the inconsistencies but virtually always have better crop quality with releases than without, and customer satisfaction surveys conducted during previous trials have shown that customers notice the difference. We were surprised to see that more farmers were motivated to try T.ost by presentations and newsletter articles than by direct contact. We need to make an effort to keep T.ost on farmers' radar screens as it is turned completely over to the private sector.

References cited

Kuhar, T. P., G. Ghidui, H. B. Doughty. 2010. Decline of European corn borer as a pest of potatoes. Online. Plant Health Progress doi:10.1094/PHP-2010-0129-01-PS

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Appendix 1. *Trichogramma ostriniae* user survey

In what state do you farm? _____

Please indicate how many acres of sweet corn, peppers, or potatoes you grow:

_____ Acres sweet corn _____ Acres peppers _____ Acres potatoes

Do you farm using organic methods? _____ Yes _____ No

Your markets: please check all that apply

_____ Roadside stand

_____ Farmer's market

_____ CSA

_____ Wholesale

_____ Produce auction

_____ Other (please specify) _____

Which of the following influenced your decision to use *Trichogramma ostriniae*? (Check all that apply)

_____ Collaborated with project staff in an on-farm demonstration

_____ Heard a presentation about *Trichogramma* at a field day or winter meeting

_____ Read a newsletter article about *Trichogramma*

_____ Another farmer using *Trichogramma*

_____ Contact with IPM Labs

_____ The online fact sheet

_____ .Other (please explain) _____

What crops are you releasing the wasps in?

_____ Sweet Corn

_____ Peppers

_____ Potatoes

Do you use insecticides **for European corn borer control** in addition to releasing wasps?

Sweet corn

___ No, I market

pesticide-free corn

___ No, I haven't needed
to

___ Yes, always

___ Yes, if fields are over
threshold

___ I don't release wasps
in sweet corn

Peppers

___ No, I market

pesticide-free peppers

___ No, I haven't needed
to

___ Yes, always

___ Yes, if fields are over
threshold

___ I don't release wasps
in peppers

Potatoes

___ No, I market

pesticide-free potatoes

___ No, I haven't needed
to

___ Yes, always

___ Yes, if fields are over
threshold

___ I don't release wasps
in potatoes

Approximately what percentage of sweet corn fields receiving *Trichogramma* releases have also needed to be sprayed **for European corn borer**? _____

Appendix 1. *Trichogramma ostriniae* user survey

Which of the following benefits have you experienced as a result of releasing *Trichogramma*? Check all that apply

- ☐ Improved quality (fewer ECB worms) at harvest
- ☐ Improved customer satisfaction
- ☐ More marketable sweet corn ears/peppers
- ☐ Increased potato yield
- ☐ Increased net income for sweet corn, peppers, or potatoes
- ☐ Fewer insecticide applications against ECB
- ☐ Reduced late season ECB pressure
- ☐ Reduced ECB pressure compared with years prior to releasing
- ☐ Reduced fuel use for ECB management
- ☐ Reduced labor costs for ECB management
- ☐ Increased acreage of sweet corn, peppers, or potatoes
- ☐ Other (please explain) _____

Overall, how satisfied are you with the results of releasing *Trichogramma*?

Not Satisfied 1 2 3 4 5 6 7 8 9 10 Very satisfied

How do you rate the process of putting *Trichogramma* out in the field?

A time-consuming pain in the neck 1 2 3 4 5 6 7 8 9 10 Very fast and easy

How do you rate the cost of releasing *Trichogramma*?

Too expensive 1 2 3 4 5 6 7 8 9 10 Very affordable

Do you expect to continue *Trichogramma* releases in the future?

Yes No

Are there obstacles to your successful use of *Trichogramma*? (if yes, please identify)

Any other comments?

Thank you!